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A.F.P. 24A
G.2 (Revised)

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122N1

497

Armament

Free Gun Air Firing

NOTES for STUDENTS

H. Q. 562-24A
20M-Mar.-43

When change bulb 30 hrs. discolour

Range estimation ~~blade~~ = 100 yds

Gravity Drop 13" 5' 13'

ARMAMENT

FREE GUN AIR FIRING

Notes for Students at
S.F.T.S., B. & G.S., A.O.S., A.G.S. and O.T.U.

SUMMARY

Part I ... The Reflector Sight - Range Estimation - Group Classification and Key Ranges - Range Estimation for Air Exercises - Cone of Fire - Bullet Group - Bullet Pattern - Gravity Drop - Harmonization and Bullet Trail.

Part II ... Parallel Course Shooting - The Zone Allowance System.

Part III ... Tracer Ammunition - Point-Blank Pattern - Pattern Produced by Gun Rotation.

Part IV ... Rules for Aiming - Curve of Pursuit Attack - Target Holding Off - Parallel Courses - Breakaway - Head-On Attack - Shallow Dive Attack - Shallow Climb Attack - Ground Strafing.

PART 1

THE REFLECTOR SIGHT

1. The reflector sight is an optical instrument designed to produce a centre spot which indicates the direction in which the guns are pointing and an illuminated ring which acts as a scale for the purpose of estimating range and the amount of allowance required. The illumination is produced electrically and controlled by a dimmer switch. The bulb can be changed when necessary and care must be taken to insert the bulb so that the mark on the bulb corresponds to the mark on the holder. The sight is also fitted with a sun screen which can be turned up for use on bright days. All external glass surfaces must be kept clean and dry. No attempt should be made to dismantle the sight apart from changing the bulb. To secure the minimum illumination at night in order to avoid dazzle, the night filament should be turned up to maximum brightness, to warm it up evenly, and then dimmed as requisite.

RANGE ESTIMATION

2. The reflector sight ring can be used for range estimation since it is of such a size that the distance between the ring and the sight centre represents 10 feet for every 100 yards range. Thus at 200 yards an aircraft of 20 feet wing span will just fill the radius and at 300 yards a 30-foot aircraft will just fill the radius, and so on, adding 10 feet to the radius for every 100 yards increase in range. It will be seen that by adding "0" to the radius of the ring we can obtain the range. The value of the radius can be obtained by comparing it with the size of the target aircraft.

GROUP CLASSIFICATION AND KEY RANGES

3. Aircraft can be classified into wing span groups starting at 30-foot wing span and increasing by 10-foot intervals, e.g., 30-foot Me. 109 E. and F.; 40-foot Hurricane; 50-foot Me. 110; 60-foot Ju. 88, etc.

4. There are three ranges which are the most important and these are 600 yards, 400 yards and 150 yards -- 600 yards is called the limiting range, 400 yards the effective range and 150 yards point-blank range.

RANGE ESTIMATION FOR AIR FIRING EXERCISES - SLEEVE TARGETS, (4 ft. low drag sleeve).

5. A 20-foot sleeve will occupy 1 rad. at 200 yards, 2/3 rad. at 300 yards and ½ rad. at 400 yards.

CONE OF FIRE

6. When a machine gun is firing the bullets do not travel along the same paths through the air due to the vibration of the gun and mounting. The bullets spread out and form a small cone called the cone of fire.

BULLET GROUP

7. The cross section of this cone at any range is called the bullet group for that range. A typical bullet group for a Browning gun in a turret mounting is 15 feet diameter at 400 yards. Other group sizes will be in direct proportion to the range, i.e., twice the range -- twice the bullet group. It must be realized that this group will only be covered after a burst of several seconds.

BULLET PATTERN

8. This is the total area covered by bullets when all guns in a turret are fired simultaneously. The size and shape of this pattern can be varied by adjusting the alignment of the guns so that the bullet groups of individual guns just touch or overlap each other depending upon the bullet pattern required.

GRAVITY DROP

9. Gravity drop is the distance the bullet falls below the line of the barrel due to the pull of gravity. This distance increases rapidly with increase of range. The approximate value at 400 yards for .303 ammunition is 5 feet. Gravity drop will decrease as the height at which firing takes place increases. Since all bullets are affected by gravity drop the effect is allowed for when harmonizing the sight. This enables the gunner to fire up to ranges of 600 yards without making any allowance for gravity drop when firing his guns.

HARMONIZATION

10. The process of harmonization of guns and sight is to adjust the guns so as to give the required pattern and to align the sight to the centre of the bullet pattern. In practice this is done by aligning the guns and sight on to marks painted on a board placed at a shorter range than the effective firing range.

BULLET TRAIL

11. Bullet trail is due to air resistance which reduces the speed of the bullet, and is seen by the gunner as a curve away from the sight centre towards the tail of his own aircraft if a tracer bullet is used. The amount of this trail depends upon the speed of the gunner's aircraft and the angle at which his gun is pointing. Allowance must be made for this effect when firing at a target by moving his guns towards the nose of his own aircraft. Typical allowances for bullet trail, when firing approximately on the beam, are:

	200 yards	400 yards	600 yards
150 m.p.h.	¼ rad.	½ rad.	¾ rad.
200 m.p.h.	½ rad.	¾ rad.	1 rad.

It will be sufficiently accurate to use the above allowances when firing at any angle within 45° either side of the beam position. It must be realized that the beam position extends all round the aircraft, i.e., vertically up and down as well as to either side.

PART 2.

DEFLECTION SHOOTING

PARALLEL COURSE SHOOTING

1. When the target is keeping station with the gunner's aircraft, the only allowance required will be that for bullet trail. If the target is approximately on the beam and overtaking the gunner's aircraft, allowance

must be made for his excess speed as well as for bullet trail. In either of these cases the allowance will be made by positioning the centre spot of the reflector sight ahead of the target. If, however, the gunner's aircraft is overtaking the target, the allowance for the excess speed is in the opposite direction to the allowance for bullet trail. It will depend upon the relative values of these allowances, whether the sight centre is placed slightly in front of, directly on, or behind the target aircraft. It must be realized that the above applies to aircraft on parallel courses, whether on the same level or on different levels.

THE ZONE SYSTEM OF ASSESSING THE SIGHTING ALLOWANCE

2. It must be clearly understood that this method is based on the assumption that the fighter is attacking by flying along a "Curve of Pursuit", i.e., with his guns bearing throughout.

3. The following allowances are to be used:

(a) When the fighter is seen in any position in the 10° cone round the dead astern line, allow $\frac{1}{2}$ rad. deflection.

(b) When the fighter is seen in the sector between 10° and 30° round the dead astern line, allow 1 rad. deflection.

(c) When the fighter is seen in the sector between 30° and 60° round the dead astern line, allow 2 rads. deflection.

(d) When the fighter is further from the dead astern line than 60° allow 3 rads. deflection.

4. In all cases the direction of the allowance will be with the centre spot between the target aircraft and the dead astern line of the gunner's own aircraft.

PART 3

TRACER

TRACER AMMUNITION

1. At the present time there are two tracers in use for air gunnery. There are the G.4 day trace and the G.5 night trace, both of which burn to a range of 600 yards.

POINT-BLANK PATTERN

2. When the tracer bullets rise rapidly to the sight centre and remain in a cluster around the centre spot until they disappear, the tracer is indicating a point-blank shot. Whenever this is seen and wherever your guns are pointing, fire point-blank at the target until the pattern changes.

TRACER PATTERN PRODUCED BY GUN ROTATION

3. When the position of the fighter is such that an allowance is necessary, position the target in your gun sight according to the allowance given by the Zone System and keep it there. When within range, open fire. A tracer pattern will be seen converging on the sight centre and then moving away, indicating the allowance required. If necessary adjust your aim to bring the aircraft to the appropriate position on the trace, as given by the following rules.

PART 4

RULES FOR AIMING

CURVE OF PURSUIT ATTACK

1. These rules are applicable for an aircraft pressing home an attack along a curve of pursuit:

(a) Recognize the aircraft.

(b) Estimate the range.

(c) Make the necessary zone allowance towards own tail.

(d) At 600 yards fire a burst and note the end of the trace.

(e) Keep firing with target at the end of the trace.

(f) At 400 yards adjust aim to bring the target half way along the existing trace.

(g) Maintain this aim and keep firing until the range closes to 150 yards. Then fire point-blank until the breakaway.

(h) On breakaway build up a deflection of 1 rad. in the direction of the breakaway, firing continuously.

TARGET HOLDING OFF

2. When the target does not press home his attack the above rules can be used up to and including rule (d). Readjust the aim using the full accuracy possible by the tracer method. That is, if the range is 600 yards, place the target just inside the end point; if at 400 yards, place the target just over halfway along the trace; and if at 200 yards, just under halfway along the trace.

PARALLEL COURSE

3. Use rules (a) and (b) of Curve of Pursuit Attack and allow 2 rads.

ahead of the target aircraft and correct aim from trace.

BREAKAWAY

4. When the fighter is breaking away after an attack along a curve of pursuit or other attack which has brought him into point-blank range, he will break away suddenly. The immediate action by the gunner should be to swing the sight along the direction of the breakaway so as to overtake the target and build up a deflection of 1 rad., maintaining continuous fire throughout the whole breakaway. On the breakaway, the rear gunner should attempt to give the nose gunner warning of the breakaway.

5. The nose gunner should, if possible, deliver a burst over the outer shoulder of the enemy aircraft as seen from the front turret, holding a deflection of 1½ to 2 rads.

HEAD-ON ATTACK

6. Open fire at 1200 yards range with a point-blank aim and maintain this aim until the target aircraft breaks away. Build up as large a deflection as possible in the direction of the breakaway.

SHALLOW DIVE ATTACK

7. When the target aircraft attacks in a shallow dive and pulls up over the gunner's aircraft, aim 1 rad. above the target aircraft and increase this allowance as much as possible after the first three seconds until the target is lost. In general, a correction of aim will not be possible if the fighter breaks away down.

SHALLOW CLIMB ATTACK

8. For this attack allow 1 rad. below the target aircraft. Increase this allowance as much as possible after the first three seconds as the fighter will invariably break away down. (In all frontal attacks open fire at extreme range, i.e., 1200 yards).

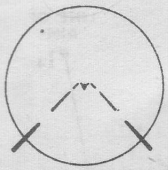
GROUND STRAFING

9. Ground strafing to be effective must be carried out at low altitudes. The front gunner should open fire with a deflection of 2 rads. short of the target and increase this deflection as the target is approached.

10. The rear gunner should open fire with a deflection of 3 rads. beyond the target and reduce this deflection as the range increases.

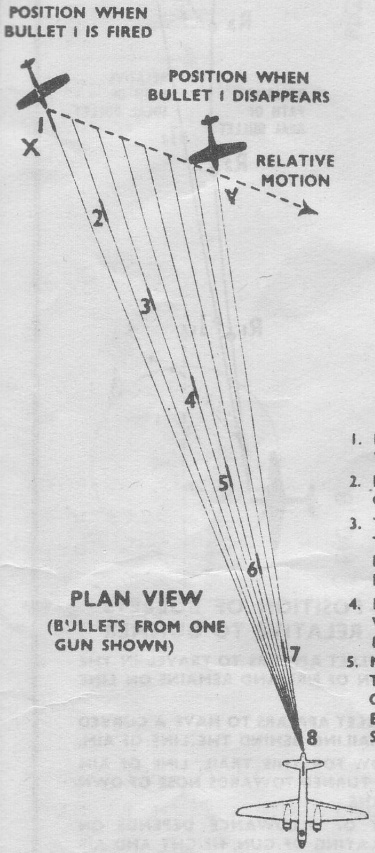
11. The above deflections can be corrected by adjusting the end point of the trace on to the target since the observed end point of the trace will always be at the range of the target.

FIG. A—TRACER PATTERN, GUNS STATIONARY

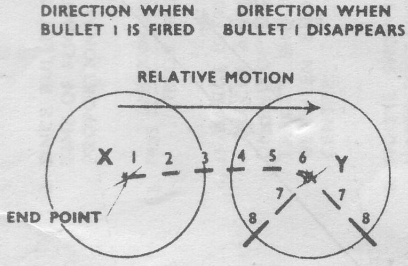


1. FIGURE SHOWS TRACER PATTERN PRODUCED BY TWO STATIONARY GUNS, FIRING G. Mk. IV TRACER, WHEN SIGHT IS MOUNTED ABOVE GUNS AND HARMONIZED FOR 400 YDS. RANGE (SEE A.D. 2170).
2. SAME PATTERN IS PRODUCED IF GUNS ARE FIRING DIRECTLY AHEAD OR ASTERN FROM AEROPLANE FLYING STRAIGHT. AIR GUNNER CAN THUS MAKE A ROUGH CHECK ON HARMONIZATION.

FIG. B—TRACER PATTERN, GUNS TURNING



PLAN VIEW
(BULLETS FROM ONE GUN SHOWN)



AIR GUNNER'S VIEW

1. FIGURE SHOWS PLAN AND AIR GUNNER'S VIEW OF SHORT BURST FIRED WITH GUNS TURNING TO KEEP TARGET STEADY IN SIGHT.
2. EACH BULLET TRAVELS STRAIGHT, BUT APPEARS TO CURVE SINCE AIR GUNNER'S EYE IS TURNING.
3. TO AIR GUNNER, BULLETS 8 AND 7 WHICH HAVE JUST LEFT GUN, APPEAR TO BE FLYING TO SIGHT CENTRE (SEE A.D. 2170), AND BULLETS 1 TO 6, INDICATING DIRECTIONS OF GUN WHEN EACH WAS FIRED, FORM A DOTTED LINE, SHOWING DIRECTION OF TARGET'S RELATIVE MOTION.
4. LINE JOINING END POINT TO SIGHT CENTRE THUS SHOWS DIRECTION IN WHICH BEAD MUST BE SET "AHEAD" TO ALLOW FOR TARGET'S RELATIVE MOTION.
5. NOTICE THAT ANGLE SUBTENDED AT AIR GUNNER'S EYE BY X Y IS ANGLE THROUGH WHICH SIGHTING LINE HAS TURNED DURING TIME OF FLIGHT OF BULLETS TO EXTINCTION RANGE OF 600 YDS. THIS FACT IS USED TO ESTIMATE AMOUNT BY WHICH BEAD SHOULD BE SET "AHEAD" (SEE SHEET 2).

PRINCIPLES OF DEFLEXION FIRE (FREE GUN)—

THEORY OF G. Mk. IV TRACER AMMUNITION

See also A.P.1730B, Vol. I, Chap. I

AIR DIAGRAM 2175 | AIR MINISTRY | MINISTRY OF AIRCRAFT PRODUCTION

Line of sight between eye and target
Point of aim = where guns are pointing

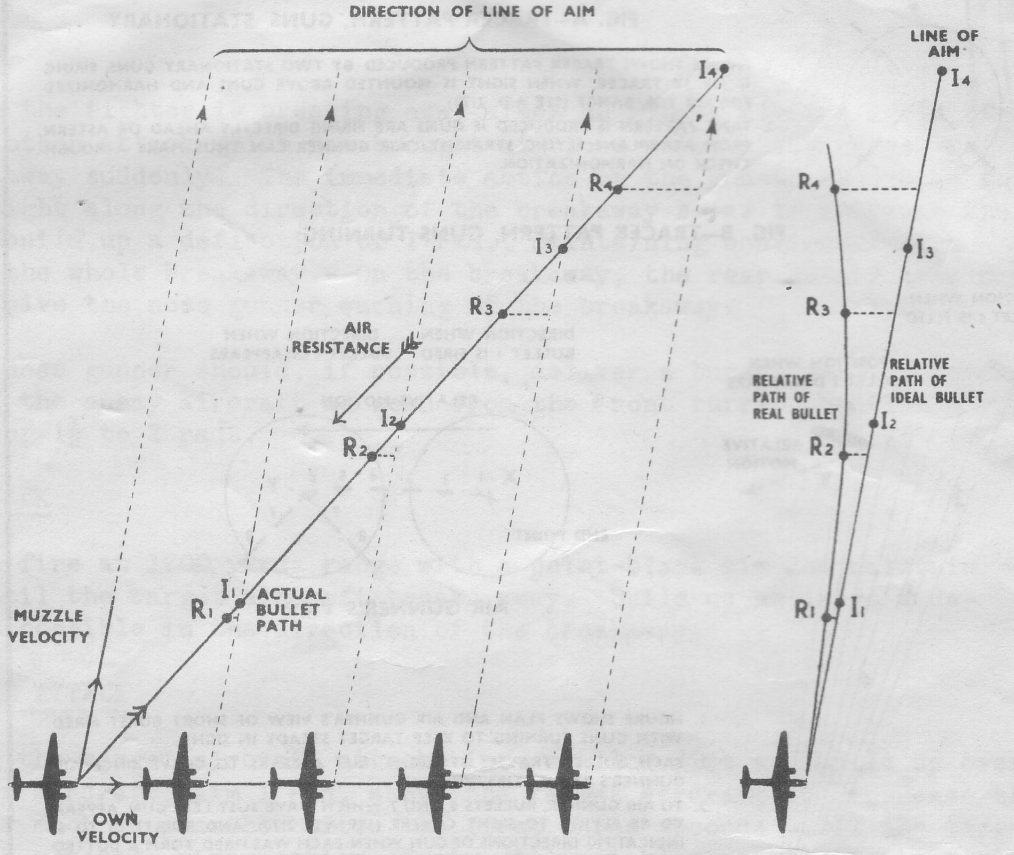


FIG. A - SUCCESSIVE POSITIONS OF IDEAL AND REAL BULLETS FIRED SIMULTANEOUSLY

1. SINCE BULLETS ARE FIRED FROM A MOVING GUN, ACTUAL BULLET PATH IS FOUND BY COMPOUNDING MUZZLE VELOCITY WITH OWN VELOCITY. BOTH IDEAL AND REAL BULLETS MOVE ALONG THIS SAME STRAIGHT PATH.
2. IDEAL BULLET IS UNRESISTED BY AIR AND TRAVELS WITH CONSTANT VELOCITY. IDEAL BULLET, THEREFORE, REMAINS ON LINE OF AIM.
3. REAL BULLET IS RETARDED BY AIR AND LAGS BEHIND IDEAL BULLET. REAL BULLET, THEREFORE, DEPARTS FROM LINE OF AIM BY RAPIDLY INCREASING AMOUNTS.

FIG. B - POSITION OF BULLETS RELATIVE TO GUNNER

1. IDEAL BULLET APPEARS TO TRAVEL IN THE DIRECTION OF FIRE AND REMAINS ON LINE OF AIM.
2. REAL BULLET APPEARS TO HAVE A CURVED PATH, TRAILING BEHIND THE LINE OF AIM.
3. TO ALLOW FOR THIS TRAIL, LINE OF AIM MUST BE TURNED TOWARDS NOSE OF OWN AEROPLANE.
4. AMOUNT OF ALLOWANCE DEPENDS ON RANGE, LAYING OF GUN, HEIGHT AND AIR SPEED OF OWN AEROPLANE, AND TYPE OF BULLET.

PRINCIPLES OF DEFLEXION FIRE (FREE GUN) –

BULLET TRAIL

See also A.P. 1730 B, Vol. I, Chap. I

AIR DIAGRAM	AIR MINISTRY			
2172	MINISTRY OF AIRCRAFT PRODUCTION			

Parallel Course Shooting
Target keeping Station – Bullet Trail only
Target Overtaking – Bullet Trail + Allowance
Target being Overtaken – No allowance } Both Cancel out

200 MPH
200 – ½° – ¼
Ramp Ra 4000 ¾ – ½
Own Speed 6000 1 – ¾

45° 45°

x Allowance
llet Trail

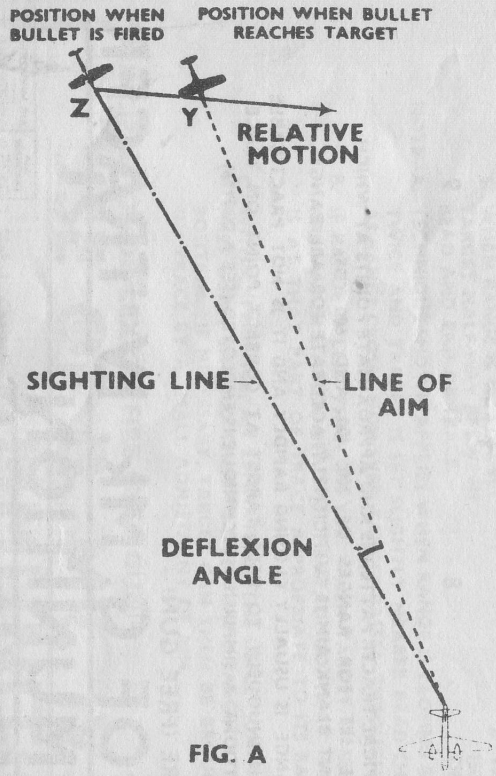


FIG. A

1. BECAUSE TARGET MOVES DURING TIME OF FLIGHT OF BULLET, GUN MUST BE AIMED "AHEAD" AT THAT POINT ON TARGET'S RELATIVE FLIGHT PATH WHERE BULLET AND TARGET WILL ARRIVE SIMULTANEOUSLY.
2. ANGLE BETWEEN SIGHTING LINE AND LINE OF AIM IS CALLED DEFLEXION ANGLE.
3. NOTICE THAT DEFLEXION ANGLE IS ANGLE SIGHTING LINE TURNS THROUGH DURING TIME OF FLIGHT OF BULLET TO TARGET RANGE.

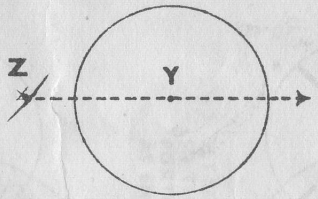


FIG. B

1. BEAD INDICATES LINE OF AIM. RING SUBTENDS FIXED ANGLE AT EYE, AND SERVES AS STANDARD FOR JUDGING DEFLEXION ANGLE.
2. BEAD MUST BE SET "AHEAD" OF TARGET IN DIRECTION OF TARGET'S RELATIVE MOTION. ZY REPRESENTS DEFLEXION ANGLE.

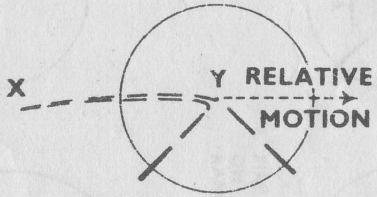


FIG. C

1. TRACER BURST SHOWS IMMEDIATELY DIRECTION IN WHICH TO SET BEAD "AHEAD."
2. ANGLE REPRESENTED BY XY (CALLED TRACER ANGLE) IS ANGLE SIGHTING LINE TURNS THROUGH IN TIME OF FLIGHT OF BULLET TO 600 YDS. RANGE (SEE SHEET 1).

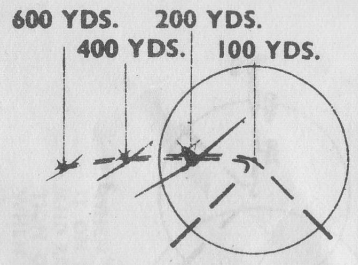


FIG. D

1. $\frac{\text{DEFLEXION ANGLE}}{\text{TRACER ANGLE}} = \frac{\text{TIME OF FLIGHT TO TARGET RANGE}}{\text{TIME OF FLIGHT TO 600 YDS. RANGE}}$
2. SINCE BULLET SPEED IS NEARLY CONSTANT, TIME OF FLIGHT IS APPROXIMATELY PROPORTIONAL TO RANGE.
3. THUS $\frac{\text{DEFLEXION ANGLE}}{\text{TRACER ANGLE}} = \frac{\text{TARGET RANGE}}{\text{600 YDS. RANGE}}$, APPROX.
4. IF RANGE IS 600 YDS., DEFLEXION ANGLE = TRACER ANGLE, AND TARGET IS SET ON END OF TRACE. IF RANGE IS 300 YDS., TARGET SHOULD BE SET HALF WAY BETWEEN END OF TRACE AND SIGHT CENTRE.
5. FIGURE SHOWS CORRECT POINTS FOR VARIOUS TARGET RANGES. BELOW 100 YDS. AIM IS POINT BLANK. PART OF TRACE RISING TO SIGHT CENTRE IS IRRELEVANT IN ASSESSING DEFLEXION ANGLE.

PRINCIPLES OF DEFLEXION FIRE (FREE GUN) –

THEORY OF G. Mk.IV TRACER AMMUNITION

See also A.P.1730B, Vol. I, Chap. I

AIR DIAGRAM 2175 PART 2 SHEET 3 — AIR MINISTRY PRINTED BY MINISTRY OF AIRCRAFT PRODUCTION

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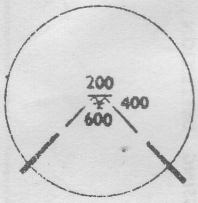

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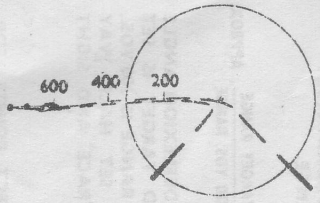

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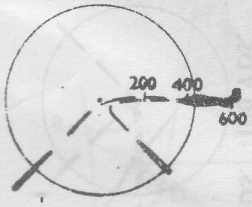

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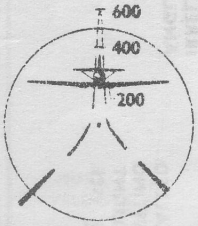

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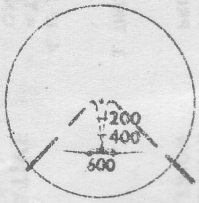

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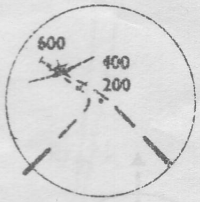

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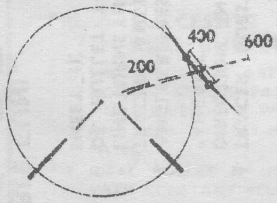

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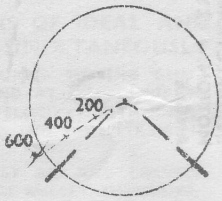

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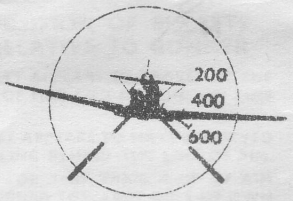

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NOTE—A. DIAGRAMS SHOW TYPICAL TRACER PATTERNS AND APPROXIMATE POINTS AT WHICH TARGET SHOULD BE SET FOR RANGES OF 200, 400, AND 600 YDS. FOR PATTERN 1, POINT BLANK AIM IS SUFFICIENTLY ACCURATE FOR ALL RANGES.

B. DURING COMBAT, RANGE IS USUALLY CLOSING RAPIDLY AND IT IS NOT PRACTICABLE TO ADJUST AIM CONTINUOUSLY TO KEEP TARGET AT CORRECT POINT ON TRACE. UNDER THESE CONDITIONS, A SIMPLIFIED TECHNIQUE IS EMPLOYED (SEE A.D. 2176)

PRINCIPLES OF DEFLEXION FIRE (FREE GUN)—

THEORY OF G. Mk. IV TRACER AMMUNITION

See also A.P.1730B, Vol. I, Chap. I

AIR DIAGRAM 2175
AIR MINISTRY
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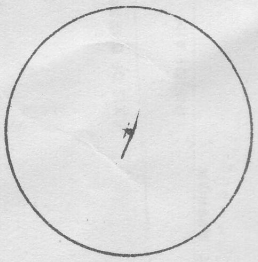
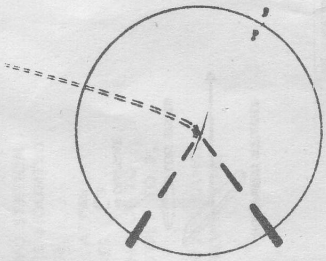
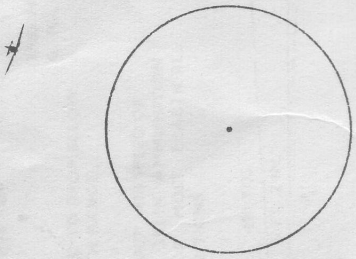


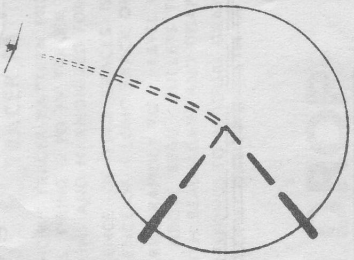
1. WHEN TARGET IS SEEN, KEEP IT ON BEAD, IDENTIFY TYPE, AND REMEMBER WHAT FRACTION OF RING IT WILL FILL WHEN RANGE IS 600 YDS.



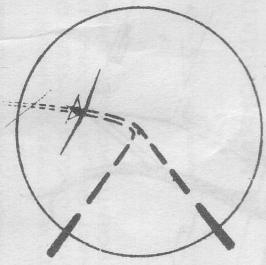
2. WHEN RANGE IS 600 YDS., FIRE A SHORT BURST, KEEPING TARGET STEADY IN SIGHT. NOTE POSITION OF END OF TRACE RELATIVE TO RING.



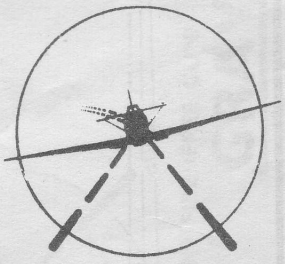
3. SET BEAD "AHEAD" OF TARGET, SO THAT TARGET IS IN SAME POSITION RELATIVE TO RING AS END OF TRACE WAS.



4. FIRE BURSTS, KEEPING TARGET ON END OF TRACE, UNTIL RANGE HAS FALLEN TO 400 YDS.



5. WHEN RANGE IS 400 YDS., SET TARGET HALF-WAY BETWEEN BEAD AND END OF TRACE.



6. WHEN RANGE FALLS BELOW 150 YDS., IGNORE TRACE, AND FIRE POINT BLANK.

NOTE—A. TECHNIQUE SHOWN APPLIES WHEN RANGE IS CLOSING RAPIDLY. AIM IS ADJUSTED TWICE AND TARGET IS SET SLIGHTLY NEARER BEAD THAN IS CORRECT FOR ITS RANGE. AS RANGE CLOSES, HOWEVER, TARGET PASSES THROUGH BULLET GROUP.

B. IF RANGE IS LESS THAN 600 YDS. WHEN TARGET IS SEEN, FIRST BURST SHOULD BE FIRED AS IN 2, THEN BEAD SET "AHEAD" SO THAT WHEN FIRE IS RESUMED, TARGET IS AT THAT PART OF TRACE APPROPRIATE TO ITS RANGE.

C. WITH EXPERIENCE, AN ESTIMATE OF THE DEFLEXION ANGLE CAN BE MADE. FIRST BURST SHOULD THEN BE FIRED WITH TARGET STEADY IN SIGHT AT ASSESSED POSITION. IF NECESSARY, TARGET CAN THEN BE BROUGHT TO CORRECT POSITION ON TRACE BY A SMALL ADJUSTMENT OF AIM.

PRINCIPLES OF DEFLEXION FIRE (FREE GUN)-

USE OF G. Mk. IV TRACER AMMUNITION

See also A.P. 1730B, Vol. I, Chap. I

AIR DIAGRAM 2176
AIR MINISTRY
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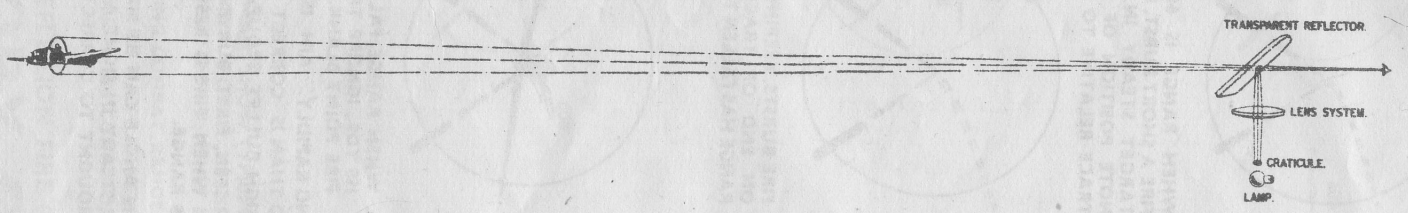
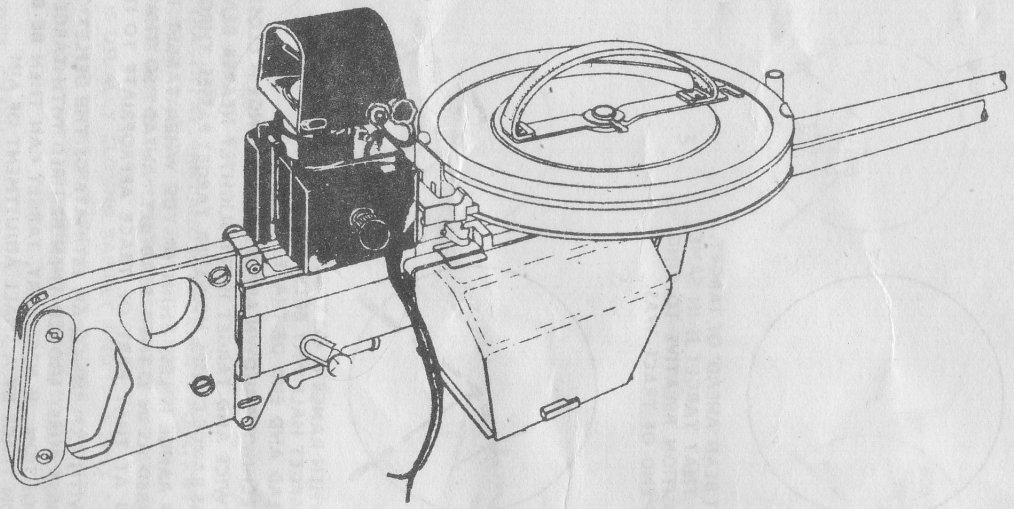


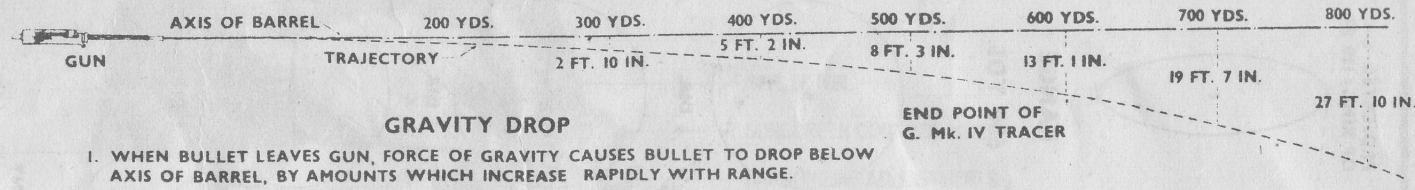


REFLECTOR SIGHT. MK. III A.

MOUNTED ON VICKERS G.O. GUN.

SHEET II.

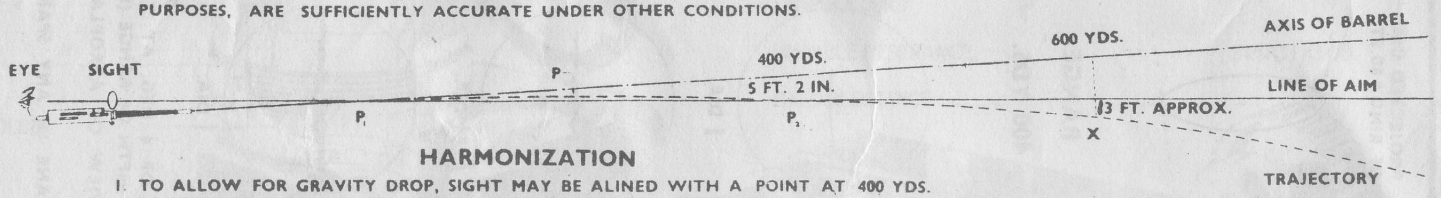
AIR MINISTRY. DIRECTORATE OF TECHNICAL DEVELOPMENT.							
OCT. 1939	AIR DIAGRAM N° 1287						
ISSUE N°	1						
DATE	Oct 39						



GRAVITY DROP

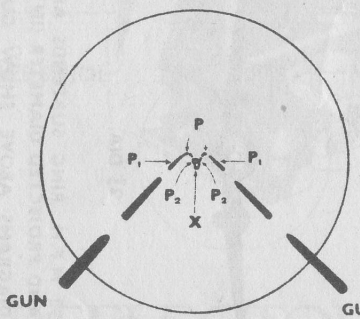
1. WHEN BULLET LEAVES GUN, FORCE OF GRAVITY CAUSES BULLET TO DROP BELOW AXIS OF BARREL, BY AMOUNTS WHICH INCREASE RAPIDLY WITH RANGE.

2. GRAVITY DROP VARIES WITH TYPE OF AMMUNITION, HEIGHT AND AIR SPEED OF AEROPLANE, AND LAYING OF GUNS. VALUES GIVEN ARE FOR ·303 IN. AMMUNITION FIRED FROM STATIONARY GUN AT GROUND LEVEL, BUT FOR MOST PRACTICAL PURPOSES, ARE SUFFICIENTLY ACCURATE UNDER OTHER CONDITIONS.



HARMONIZATION

1. TO ALLOW FOR GRAVITY DROP, SIGHT MAY BE ALINED WITH A POINT AT 400 YDS. RANGE, 5 FT. 2 INS. BELOW AXIS OF BARREL. SIGHT IS THEN SAID TO BE HARMONIZED FOR 400 YDS. RANGE.
2. WHEN THIS IS DONE, GUNNER CAN IGNORE GRAVITY DROP UP TO 600 YDS. RANGE, SINCE TRAJECTORY DOES NOT DEVIATE MUCH FROM LINE OF AIM.



TRACER PATTERN

1. FIGURE SHOWS TRACER PATTERN PRODUCED BY TWO STATIONARY GUNS, FIRING G. Mk. IV TRACER, WHEN SIGHT IS MOUNTED ABOVE GUNS AND HARMONIZED FOR 400 YDS. RANGE.
2. CONVERGENCE OF TWO TRACES IS SIMILAR TO APPARENT CONVERGENCE OF A LONG TRACK OF RAILWAY LINES.
3. BULLETS RISE RAPIDLY TO P_1, LEVEL WITH BEAD, AND UP TO P, SLIGHTLY ABOVE BEAD. BULLETS THEN FALL SLOWLY TO P_2, LEVEL WITH BEAD AGAIN AND DISAPPEAR AT X.
4. P_2X CORRESPONDS TO RESIDUAL GRAVITY DROP AT 600 YDS. RANGE AND OCCUPIES ONE-TWENTIETH OF RADIUS OF 50 M.P.H. RING.

PRINCIPLES OF DEFLEXION FIRE (FREE GUN) –

GRAVITY DROP

See also A.P. 1730 B, Vol. I, Chap. I

AIR DIAGRAM 2170 — AIR MINISTRY — MINISTRY OF AIRCRAFT PRODUCTION

A.P.P. 24
G.2(Revised)

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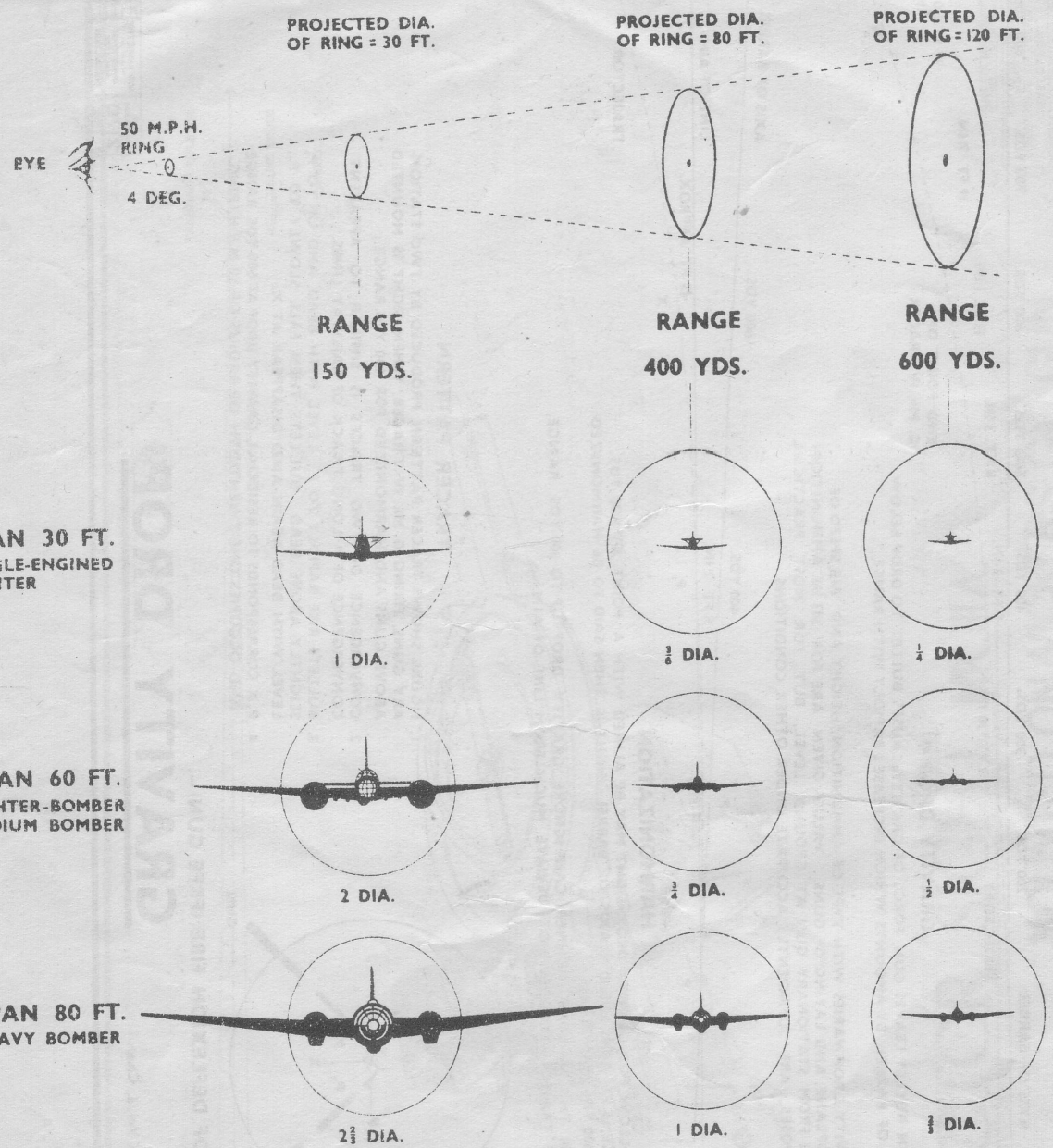

NOTE.—

1. 50 M.P.H. RING SUBTENDS AN ANGLE OF 4 DEG. AT THE EYE, AND PROJECTED DIAMETER (IN FT.) = ONE FIFTH OF RANGE (IN YDS.).
2. DIAGRAMS ABOVE SHOW GUNNER'S VIEW OF AEROPLANES OF VARIOUS SPANS AT VARIOUS RANGES.
3. FRACTION OF RING FILLED BY AEROPLANE OF ANY SPAN AT ANY RANGE = $\frac{5 \times \text{SPAN (IN FT.)}}{\text{RANGE (IN YDS.)}}$

PRINCIPLES OF DEFLEXION FIRE (FREE GUN)—

RANGE ESTIMATION

See also A.P. 1730B, Vol. I, Chap. I

AIR DIAGRAM 2168
AIR MINISTRY
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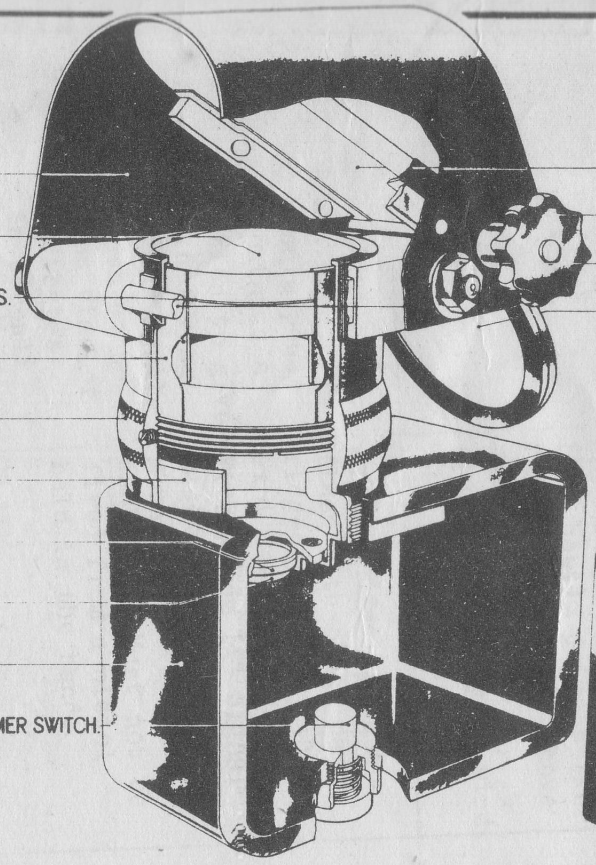
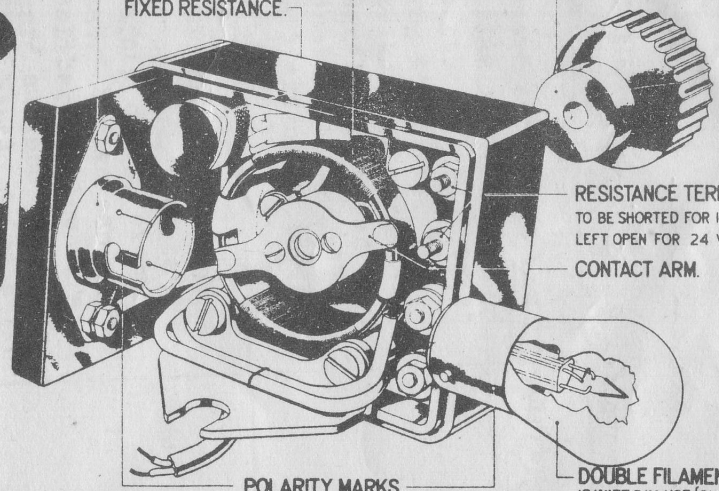
P.1679. 26017. M.1392. 49.000. Gp.959. M&S. 9/42

P1679



PROTECTIVE HOOD.
OPTICAL SYSTEM.
INTER LENS SEPARATORS.
RESILIENT LINER.
LENS TUBE.
GRATICULE HOLDER.
GRATICULE.
GRATICULE LENS.
BODY.
PLUNGER. RETAINING DIMMER SWITCH.



REFLECTOR.
SUNSCREEN CONTROL KNOB.
HARMONIZING ADJUSTMENTS.
SUNSCREEN.
LAMP HOLDER.
VARIABLE RESISTANCE.
FIXED RESISTANCE.
SWITCH KNOB.
RESISTANCE TERMINALS.
TO BE SHORTED FOR 12 VOLTS.
LEFT OPEN FOR 24 VOLTS.
CONTACT ARM.
POLARITY MARKS.
DOUBLE FILAMENT LAMP.
18 WATT DAY USE (ON-OFF).
24 W. (12 V.) 6 W. (24 V.) NIGHT USE (DIMMER).

REFLECTOR SIGHT. MK. III A.
FOR FREE GUN.

SHEET 1.

AIR MINISTRY. DIRECTORATE OF TECHNICAL DEVELOPMENT	
JUL 1939	AIR DIAGRAM N° 1287.
ISSUE NO	1
DATE	Jan 39

15

A.T.P. 24
G.2 (Revised)

[illegible] straight astern bullet trail [illegible] in [illegible]
& no allowance is made for it.

1. Target keeping station on the Bomber.
2. Only allow for bullet trail see page 3.

A. Target a/c overtaking bomber.

Bullet trail allowance for difference in speed.

B. Bomber overtaking Fighter a/c.

Bullet trail may cancel out allowance for speed.

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